

Designing an Emergency Medicine Physician Workstation to Support Risk Management in Decision Making

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The practice of emergency medicine requires rapid decision making. The speed of decision making in the face of limited information contributes to the high risk of medical malpractice suits. We explore design approaches to an emergency physician electronic medical record product, EMstation™, that may reduce the risk of adverse medical events by providing cues and tools while the patient may still be in the emergency department. EMstation is an Emergency Medicine Physician Workstation based on a Microsoft Windows 3.1™ user interface. Because adaptation and adaptability to physician needs are critical to user acceptance, design to workflow, multisite end user customization, and integrated database support are used to support risk management documentation in EMstation. This article describes techniques that can be incorporated into electronic medical products which may prevent adverse medical events.

NATURE OF RISK IN THE EMERGENCY DEPARTMENT

The Emergency Department Environment

The emergency department is the third highest risk setting based on malpractice claims, following only the obstetric suite and the operating rooms. In contrast to primary care settings, decision making in the emergency department is based on incomplete clinical data and the patients tend to be strangers. Unpredictability of workloads leads to busy peak flow periods when documentation becomes particularly difficult. Poor clinical decisions, lack of patient rapport, and poor documentation are all factors known to lead to malpractice suits.¹ Risk management strategies that are available at the time of documentation offer the chance for real time risk reduction if the patient is still in the department (as is often the case given waits for labs, x-rays, and consultants).

Historical Patterns of Risk

Several major retrospective studies of emergency medicine malpractice suits have shown that a small

set of repetitive clinical errors generates over 50% of dollars paid out to plaintiffs.²⁻⁴ This so-called "closed claims" data starts with all malpractice suits initially filed during a given time period, but waits to assess results until they have all come to a final disposition. This data tends to lag clinical practice because some of the suits may take 6 to 8 years before all appeals are exhausted. Missed myocardial infarction, appendicitis, ectopic pregnancy, subarachnoid hemorrhage, meningitis, missed tendon lacerations, and retained foreign bodies within wounds typically account for over half of all dollars paid out. Missed myocardial infarction alone is the cause for over 25% of payments in these studies.

Nature of Errors and Behavior Modification

Inherent in proposing computer documentation for risk management are the assumptions that alerting physicians to high risk clinical presentations and encouraging documentation to address these scenarios can prevent bad outcomes.⁵ The American College of Emergency Physicians believes this to be true and has issued clinical guidelines for clinical problems such as chest pain and pediatric fever.^{6,7} Empirical evidence from various studies suggests that there are a variety of failure modes in malpractice cases (e.g. failure to order an EKG, errors in reading an EKG, diagnosis of the wrong process such as gastroenteritis instead of cardiac ischemia).⁸ This paper discusses possible risk management tools and leaves to further research evaluation of those tools in addressing specific failure modes.

CURRENT RISK MANAGEMENT EFFORTS

Manual or Retrospective Audits

Currently the mainstays of risk management and quality assurance in emergency departments are a global commitment to "good medicine" and specific retrospective chart review based on JCAHO criteria as well as department-specific retrospective chart reviews.⁹ These activities are generally based on handwritten or transcribed records.

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Review of Computerized Methods

Computerization of the medical record could potentially reduce adverse clinical outcomes by providing data to the clinician *while* they are treating the patient. Areas of medical computerization specifically directed at reducing risk include clinical alerts, text string searches for high risk presentations, and electronically implemented documentation guidelines.

Alerts

Clinical alerts are designed to highlight abnormal sentinel lab values or events. In situations where the failure mode is based on a clearly definable signal (e.g. toxic level of digoxin) rather than a sequence of events (misdiagnosis of myocardial infarction), they are very effective.¹⁰

Free Text Methods

John Holbrook has pioneered string search based analysis of emergency department charts using algorithms designed in conjunction with the Massachusetts Chapter of the American College of Emergency Physicians.¹¹ The ChartChecker system searches for several key documentation text strings in predefined high risk presentations. While this has the significant benefit of focusing physician attention on high risk presentations, it requires learning and use of very specific character strings. The physician needs to both use a computer (or have extremely rapid transcription) and then have the program analyze the note while the patient is still in the department in

order for this to be near real time.

Myers and Culp are working on broadly based text searching based on indexing text and text attributes and linking this to an object oriented database.¹² This concept may let physicians escape the need to adapt their terminology to rigid system constraints at the cost of a greatly increased computational load. As with the ChartChecker system, unless coupled to templates, chart entry will be free form and physicians will not receive feedback until after they have already completed one pass at documentation.

Structured Text Based Methods

Free text dictation requires only a small effort to learn but correspondingly provides limited opportunities for behavior modification and quality improvement through consistency. Structured dictation, by definition, limits flexibility but promises more uniform data necessary for quality initiatives or clinical research. The gastrointestinal endoscopy community has promulgated documentation guidelines for endoscopy reporting.¹³ Research in this area has shown a drop in omissive errors from 48% to 18% when switching to structured reporting.¹⁴ In the emergency medicine literature, Humphreys et al have also found a 10% improvement in documentation using preformatted charts.¹⁵ Given the emphasis on documentation in emergency medicine risk management, any reduction in omissive errors is important.

METHODS

Any approach to risk management has to be used in order to work. Given the very limited usage of computers for patient records, the most critical feature of any computer based risk management system is usability.¹⁶ Following description of the hardware and software used and the methods for incorporating risk management will be a description of several of the key features to enhance usability.

Multimodal Graphic User Interface

EMstation version 3.5 is a software package supporting both template based and free text dictation for emergency medicine physicians with an integrated database. The workstation environment is written

EMstation 3.50b17 - [Samuel Smith]

EMstation Visit Edit Dictate Browsers Window Help

Complete reports Chest pain

Samuel Smith CHESTPAIN MRID: MR1023 Phys: Undict

Patient seen: 9:32 AM

Patient arrived by ambulance. Source of history: Paramedic and wife. 53 year old male presents with [COMPLAINTS] for [TIME].

[CHEST PAIN DESCRIPTION] Risk factors: [RISK FACTORS]

[OTHER HISTORY/ROS]

PE: [PE]

[INITIAL IMPRESSION/DIFFERENTIAL]

TREATMENT & COURSE: [TREATMENT & COURSE]

[ASSESSMENT/DISPOSITION/PLAN]

[Chief Complaints]

CONTINUE

— High risk symptoms —

Chest discomfort

Chest pain

Chest tightness

Diaphoresis

Nausea

Nausea & vomiting

Palpitations

Shortness of breath

Sweating

Vomiting

Abdominal pain

Apprehension

Claudication

Cough

Difficulty breathing

Difficulty swallowing

Dizziness

Fatigue

Fever

Heartburn

Hemoptysis

More Choices

Samuel Smith Rucker, Donald W., MD No Voice NUM 9:32 AM

Fig. 1. Structured dictation screen. High risk symptoms are in red.

in Borland C++ under Microsoft Windows 3.1 for a Pentium™ class personal computers. The typical primary mode of interaction with the system is by mouse clicks on menu-based templates. Pen computing using Microsoft Windows extensions is supported. Additionally, automated speech recognition is incorporated by inclusion of Dragon Dictate™, a 30,000 word speech recognizer by Dragon Systems with a special emergency medicine vocabulary and language model based on review of 45 million words of emergency note dictation. Dragon Dictate is integrated to provide separate support for speech recognition of menu choices. Digitized storage of dictation for later transcription is also available. The construction of EMstation represents approximately 60 person years of direct programming by a team of "C++" programmers as well as a similar time spent by physicians designing templates.

Template Based Dictation

Template based dictation is supported by approximately 250 clinical scenarios with complete prompting of the history, physical exam, diagnosis, and treatment. The core paradigm is the presentation to the user of a series of menus that walk the user through the history, physical examination, diagnostic workup, treatment and patient discharge. The templates are written in MEDtalk III, an in-house compiled programming language supporting Boolean logic to display text, calls to external databases or functions, and correct grammar for subject verb number agreement and complex noun phrases.

At any point in generating the note, the physician can switch to free text, using voice recognition or by typing on the keyboard. The base design assumption is that the bulk of the notes will be done using a template either in whole or in part and this appears to be the case from interviews with the EMstation user community.

All notes are stored as text with codified demographics and ICD9/CPT4 coding. Physicians can retrieve charts of discharged patients or patients currently being treated at any time. Retrieval of charts is by partial string matching on the name or record number.

INCORPORATING RISK MANAGEMENT

Sources

Risk management guidelines are based on the closed claims studies cited above. The American College of Emergency Physicians provides extensive literature

on risk management as well as formal guidelines for various clinical presentations. Templates address high risk misdiagnosis of myocardial infarction, intracranial bleed, meningitis, appendicitis, ectopic pregnancy, retained foreign bodies in wounds, and neurovascular or tendon compromise in lacerations.

Risk management is incorporated directly into the templates rather than applied after the fact. Complete reports are designed so that at several points in the process menus are presented that capture data for documentation standards. The menus highlight and label key symptoms, signs and lab examinations. Thus, for example, in chest pain or related complaints, the physician is prompted for associated symptoms such as nausea, diaphoresis or palpitations (See Figure 1). Next he or she is explicitly asked about cardiac risk factors. Proceeding through the template, the EKG is the highlighted diagnostic maneuver.

Special Features for Risk Management

Given the significant demands for usability, EMstation incorporates a number of risk management enhancements, all of which were based on field experience and added since version 1.0.

All high risk items are displayed in red in contrast to other selectable menu items displayed in blue. Users can select additional items to the color red based on their own needs and further research results. As with any other template customization, this is done through dialog boxes requiring no programming skills (See Figure 2).

With the growing emphasis on continuous quality improvement, template edits can be done simultaneously by individual users on their own versions of the templates and by ED groups or departments on master templates. Templates sit as a hierarchy of product, site, and user customization layers that are seamlessly interleaved at runtime.

The incorporation of both free text and structured dictation within EMstation naturally sets up a clash between unlimited expressivity and guided consistency.¹³ Given the limitations of free text outlined above and decreased usability inherent in a totally template driven approach, EMstation must support both modes throughout. Individual physicians or groups can alter the balance with a customization tool called Medit by setting menus as either skippable or required depending on how important they feel documentation choices on any menu are (see Figure 2). Individuals and groups can

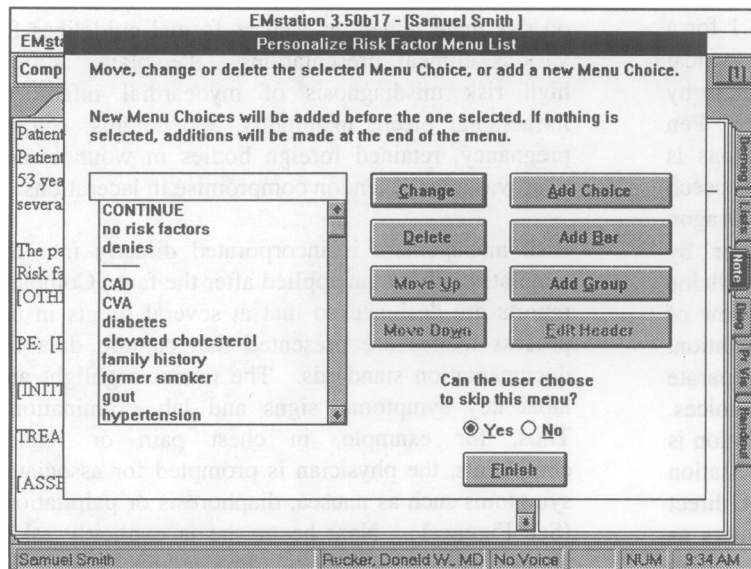


Fig. 2. Customization screen.

require more or less menu choices depending on how they make their own tradeoff between increased time costs to document versus benefits of documentation.

Two specific risk management tools are incorporated. One is a package of customizable patient instructions available at any time. These are important because as much as half of all litigation surrounding the emergency department is based on events after discharge.¹ Secondly, an emergency medicine risk management syllabus by Henry and Little is packaged as a hypertext browser.¹⁷

CLINICAL USABILITY

Usability has been the biggest barrier to computerized medical records.¹⁸ The time demands of emergency medicine require a fast, easy to use system.¹⁹ EMstation was designed from the start with two assumptions. One was that direct physician data entry is critical for workable electronic records.²⁰ The second was that the users would decide how they interact with the system. At almost all times, users may freely choose among mouse, voice or keyboard. These can be mixed as desired.

Workflow issues are addressed in a number of ways.²¹ Data can be input by a mix of mouse, pen, voice, voice recognition and typing. Users can switch back and forth between partially completed notes on patients still in the department. HL7 and printer-based emulation interfaces allow automatic downloading of data. Directed, configurable printing and faxing is automatic upon electronically signing the note. Prescriptions can be written without leaving the product. These features may not seem

immediately relevant to risk management but serve the overriding goals of speed and ease of use.

EMstation also recognizes that personalization of the text output is critical to user adoption. Highly trained professionals will likely want to have involvement in implementing system design and ensuring that there is a good fit with their personal style. EMstation facilitates this with Medit, a customization tool that is geared to allowing changes in menus and setting default choices for report components such as the physical exam based on patient's presenting complaint, age, and sex.

Chart legibility has long been a classic risk management issue, given the widely noted quality of physician penmanship. MEDtalk based templates address this aspect of risk management with syntax to support legible and polished text output. Thus, multiple menu choices will have appropriate verb changes and punctuation. The syntax and customization support is based on an underlying object oriented architecture for the text templates. This stands in contrast to the option of building templates by simple string insertions.

DATABASE SUPPORT

The above features address risk management at the time of chart generation. The integral database offers quality assurance and risk management review options retrospectively as well.

Database capture of notes is automatic upon either electronically signing the note or placing it on hold for later completion. The bulk of the note is captured as text narrative. Demographics, chief complaints, diagnoses, and procedures are also captured as codified fields. EMstation's built-in database allows chart retrieval based on patient or complaint category. Additionally, the whole database is exportable by an included utility program. The authors have used this to construct more powerful chart audit programs based on physician, visit, demographic, and diagnosis categories using the codified data with interfaces designed using Microsoft's Excel™ and Access™.

EVALUATION

EMstation is currently in use or being installed in approximately 40 sites. This paper addresses design issues in software-based risk management. Research

is needed to evaluate the design assumptions. Malpractice suits and easily identifiable malpractice events are relatively rare. Further research will likely have to focus on process measures (such as documentation) rather than outcome measures.

CONCLUSION

Physician workstations in the emergency department offer ways to enhance near real time or real time risk management. As with all components of a computerized medical record, design for speed and ease of use are the biggest challenges and underlie any risk management approach. The EMstation architecture of a graphic user interface with predominantly template driven data capture with multiple modes of data entry supported by a variety of customization tools may reduce the risk of medical errors in patient care in the emergency department.

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